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One-dimensional model of fluids of third grade in straight tubes with constant radius

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Abstract

In recent years the Cosserat theory approach has been applied in the field of fluid dynamics to reduce the full three-dimensional system of equations of the flow motion into a one-dimensional system of partial differential equations which, apart from the dependence on time, depends only on a single spatial variable. Applying this approach theory in the particular case of a straight tube of constant circular cross-section, we obtain a one-dimensional model related with the flow of a viscoelastic fluid of differential type with complexity $n = 3$. From this reduced system, we derive unsteady equations for the wall shear stress and mean pressure gradient depending on the volume flow rate, tube geometry, Womersley number and viscoelastic coefficients over a finite section of the straight rigid tube. Attention is focused on some numerical simulations of unsteady flow regimes.

Keywords

One-dimensional model, Viscoelastic fluid, Unsteady flow, Hierarchical theory, Cosserat theory.

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